Progress Report on the Clinical Workstation and Clinical Data Repository at UNC Hospitals

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Abstract

In 1991, we demonstrated a prototype version of the Clinical Workstation at SCAMC. At the present time 48 workstations have been implemented in the ambulatory care areas of the Hospital. We describe the present functionality of the workstation and the work done to date on the clinical data repository.

Introduction

We demonstrated the prototype Physician's Workstation at the 15th Symposium for Computer Applications Medical Care in 1991 (1). Because of the likelihood of use by other members of the healthcare team, the workstation name was changed to the Clinical Workstation (CWS). The CWS provides the user with a graphical user interface (GUI) to clinical information from a variety of computer applications and computer systems. These applications include the SMS Patient Index, the Appointments Database and the internally developed Mini-Medical Record system containing problem list and drug prescription data (2). Laboratory data was obtained by CWS automatically logging on to the Laboratory Information System, extracting the requested data and displaying it to the user via the GUI interface. The CWS was designed to take advantage of the existing token ring and TCP/IP network communication systems available at UNC Hospitals and School of Medicine.

The first goal for the workstation project was to give the physician user the illusion that the data was obtained from a single integrated information system while that system is being built over the next few years. The second goal of the workstation project was to make it possible for departmental information systems in the Hospital to evolve without requiring retraining of all physician users when these systems changed. The third goal of the project was to develop a Clinical Data Repository (CDR) using IBM's Relational Database Manager DB2 that would store radiology results, clinical and anatomic pathology results, discharge summaries, op-notes and clinic notes. The fourth goal of the project was to develop HL7 interfaces between departmental systems, where this standard was supported, or locally develop Application Program to Program Communications (APPC) using the LU 6.2 standard when necessary. The purpose of this paper is to report the progress toward achieving these goals made during the last fifteen months.

Hardware, Software and Network Environment

The CWS is an IBM PS/2, model 57 with 12 mbytes of RAM running the IBM OS/2 1.3 Extended Edition operating system. Currently we are evaluating the OS/2 2.0 version of the operating system. Access to the UNC Hospital IBM ES9000 computer and the School of Medicine's distributed computing environment is provided via token ring network and the OS/2 Communications Manager, and TCP/IP v1.1 (IBM Corp., Armonk, NY). The CWS application is written in EASEL v2.0 (Easel Corp., Burlington, MA) programming language with some C language communication subroutines. The Easel Workbench tool set provides a functionally rich environment for the development of the CWS. Routers (Cisco Systems, Menlo Park, CA) are used to bridge between the token ring network in the Hospital and the ethernet in the School of Medicine.

Laboratory data is transferred from the Laboratory Information System (LIS) (CHC, Houston, TX) to the clinical observation and results (COR) reporting system (SMS, Malvern, PA) via the HL7 interface. The CDR is populated by data transfer from the SMS COR system into the DB2 database via a custom interface developed by the staff of UNC Hospital Information Services Division (ISD). Radiology data (CHC, Houston, TX) and anatomic pathology data are currently moved from the radiology information system and LIS, respectively, to the CDR by daily tape transfers. This tape transfer system is temporary until the HL7 interface is completed by SMS and CHC for this text based data.

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Clinic notes, operative notes and discharge summaries are transferred from the Hospital's dictation system (Softmed Systems, Bethesda, MD) via an internally developed (APPC) program using the LU 6.2 protocol. Access from the physician's office to the transcription system is provided either via the token ring network of the Hospital or the ethernet system of the School of Medicine, depending on the location of the office.

The Information Management Challenge

Construction of a new Ambulatory Care Center (ACC) stimulated a review of information management process in the Medical Center. The ACC was the first building not physically connected to the UNC Medical Center. It was recognized by the leadership of the Medical Center that information transfer could no longer rely exclusively on paper medical records due to the logistics of moving the chart between buildings. It was recognized that a significant part of the paper medical record was in electronic format in a variety of departmental systems. Further, the Medical Center had a major financial investment in the departmental systems and needed to use them as efficiently as possible while trying to meet the challenge of developing and implementing an integrated medical information system.

Between 1986-90, the Medical Center had seen the implementation of network systems that allowed the user to logon to both the hospital information systems as well as the various departmental systems. The physician user was then faced with the challenge of learning to navigate the network and deal with the different terminal types and user interfaces for the various systems. Further complicating the use of these systems was the security process used by each application that might require the user to have as many as five to ten logon codes and passwords to obtain information from these "clinical" applications. Clearly, in today's busy patient care environment such a system was not viable.

The ACC opened in December 1992, and currently serves the Departments of Medicine, Pediatrics, Obstetrics and Gynecology, Surgery and Dermatology, and by May 1993, the ACC will be fully operational. In addition to the clinics the ACC contains a Day-Op facility with four operating rooms.

The Clinical Workstation

The major design goal of the clinical workstation was to make the access system for clinical data uniform, simple and fast. The graphic user interface has in recent years become the defacto standard interface for all modern software development and is provided by the Easel programming environment. Forty-eight version 2.0 workstations (1) are in use in the ACC and other ambulatory care areas in the Medical Center.

The user begins by logging on to the CWS using the dialog box that prompts for his logon code and password. The CWS then queries the mainframe for the passwords for all applications and computer systems that the user needs and then logs on to these systems. If a password for an application expires, the user is prompted to enter an new password. The mainframe security system encrypts the new password and adds it to the security table. The application password can be anything the user wants and the user does NOT need to remember it. Next the user is given a dialog box that asks for a first and last name for a name search or for the patient's medical record number, if known. If a name was entered, the system will display a list of names with the age and race of the patients. The user picks from this list the patient on which information is desired. The entry of a medical record number will uniquely identify the patient and go directly to the first screen shown in Figure 1.

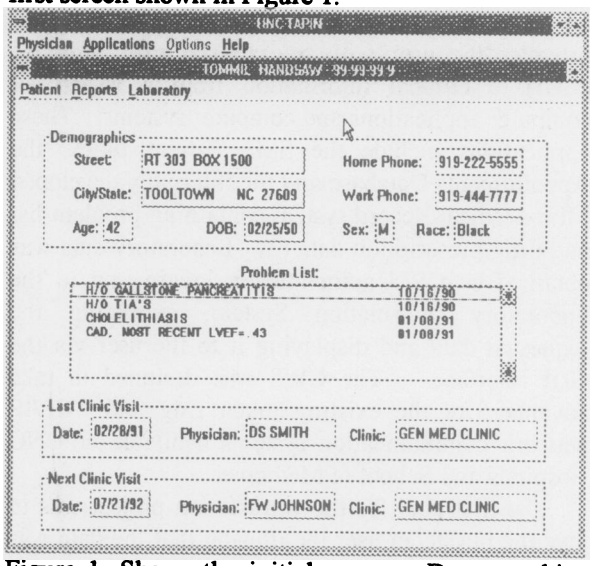

Figure 1. Shows the initial screen. Demographics and appointment data are from the SMS system. The problem list is extracted from the Mini-Medical Record System. Patient is fictitious.

Figure 1, shows two title bars and menu bars. The full name of the application **UNC TAPIN** is shown in the upper title bar. The second title bar gives the name and medical record number of the patient selected. The upper menu bars gives the options for the user to obtain non-patient care

information and the lower menu bar allows the user to retrieve clinical information on the selected patient.

The Upper Menu Bar

The non-clinical information menu bar options are labeled: Physician, Applications, Options and Help. Selecting "Physician" opens an option box that contains the following options: *Logon, Select Patient, Appointment Schedule, O/R Schedule, Comments, and Reset/Logoff.* These options have the following functions: *Logon* allows the user to open a dialogue box that asks for logon code and password; *Select Patient* allows the user to enter either the first and last name of the patient or the medical record number; *Appointment Schedule* allows the user to look at any physician's clinic schedule up to one month in advance or one month back in time; *O/R Schedule* allows the user to review the operating room schedule by room, surgeon, date, anesthesiologist and patient; *Comments* allows the user to report problems or other information to the CWS development team; and *Reset/Logoff* allows the user to logoff the system.

Selecting "Application" from the upper menu bar allows the user to access information systems in the distributed computing domain of the School of Medicine Information Network (*SOMIN*) that includes a local MedLine database containing all citations from the medical literature for the last five years. The second application available is *Email.* The Email option allows the user access to the Da Vinci Email system. The next item from the upper menu bar is "Option" which is reserved for future functions and is grayed out at this time. The last upper menu bar option is "Help" that gives the user access to on-line context sensitive help for TAPIN.

The Lower Menu Bar

This menu bar provides access to patient information for the patient that has been selected, under the categories of "Patient", "Reports" and "Laboratory".

If "Patient" is selected from the menu bar, an option box opens allowing the selection of *Current Medications* or *Specialty Clinics.* The *Current Medications* window displays a list box of all currently prescribed medications, as well as the patient's drug sensitivity. The list box of medications includes the Rx date, quantity, and an indicator whether the prescription was filled at UNC Hospitals. It also specifies the number of refills possible and the number of refills left available. Selecting the *Specialties Attended* allows the user to view previous visits to specialty clinics in ambulatory care. The Specialty Areas dialog box appears showing all the specialty areas this patient has visited and allows the user to select a clinic for the display of additional ambulatory clinic information. The Specialty Areas dialog window is replaced by the Clinical Data dialog window. As shown in Figure 2, below, data displayed in the Clinical Data window includes appointment information, primary physician, and vital signs. The user can access the text of clinical notes from these visits by clicking the clinic note button at the bottom of the box.

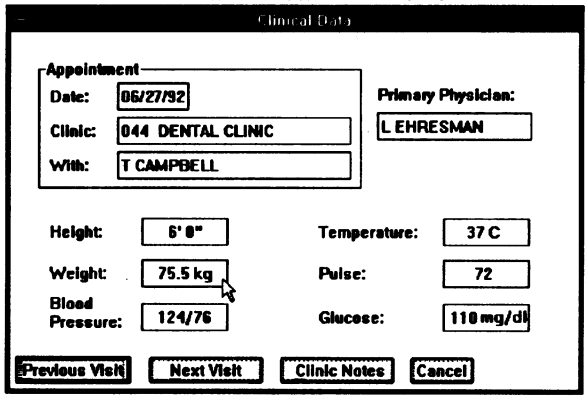

Figure 2. Shows the Clinical Data dialog box.

Selecting the "Reports" menu bar item opens an option box that contains the following options: *Discharge, Operative Notes, Radiology* and *Clinic Notes.* Selecting any of these options opens the dialog box shown in Figure 3.

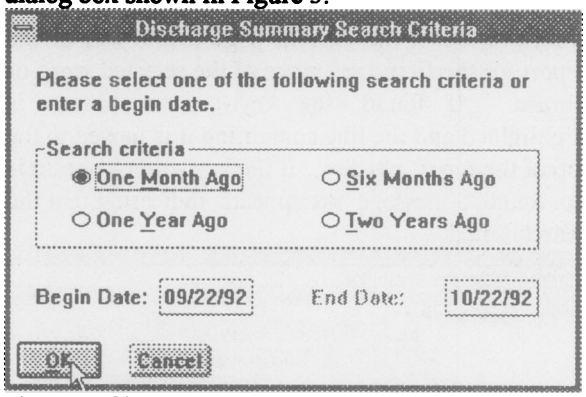

Figure 3. Shows search date range criteria choices.

This dialog box allows the user to specify the date range for the report search. If the patient has existing discharge summaries, for example, then the Select a Discharge Summary Report window appears displaying the dates and final diagnoses of all reports found. The user clicks on the line containing the discharge date of the desired report, and presses the *OK* push button to examine the contents of the report.

Figure 4, below, shows the beginning of the discharge summary report. The user may review the document by using the page up and down keys or the scroll bars at the right side of the dialogue window.

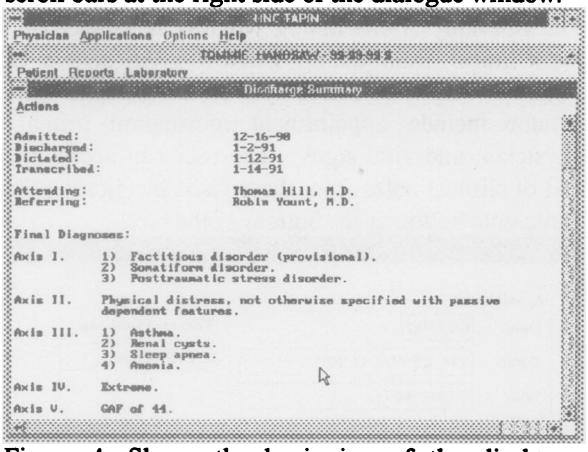

Figure 4. Shows the beginning of the discharge summary.

The Discharge Summary window has its own action bar located across the top of the window, with one pull down choice, Actions. The Actions pull down choices include: Keyword Search, More Reports and Exit.

The user selects *Keyword Search* to locate a particular section in the report. The Search For Keywords and Phrases window opens. The user selects the desired search word or phrase and click on the *OK* button. The CWS searches the document from the top of the current page to the end of the report for the first occurrence of the selected word or phrase. If found, the keyword or phrase is highlighted and the line containing it is moved to the top of the report window. If the keyword or phrase is not found, a message box appears, indicating that the search failed.

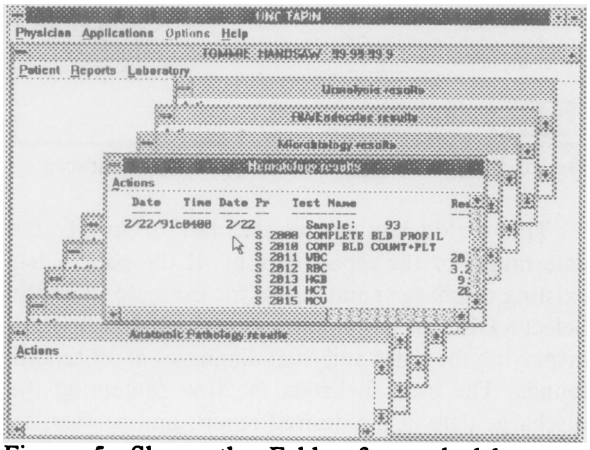

Figure 5. Shows the Folder for each laboratory section as well as a partially opened display of the Hematology Laboratory data.

Selecting the *More Reports* allows the user to return to the report selection box and review other reports. The *Exit* option allows the user to leave the review report function.

If the "Laboratory" is selected from the menu bar, an option box opens allowing the selection of *Folders* or *Search Criteria*. The *Search Criteria* option opens a dialog box that allows the user to modify the date range for the search of laboratory data much like the search criteria dialog box shown in Figure 3. Selecting the *Folders* option creates a folder for each of the main sections of the laboratories as shown in Figure 5, above.

In Figure 5, the Hematology folder has been opened. Double clicking on the resulting Hematology window will open it to full size. The user may review the data by either using the scroll bars with the mouse or by pressing the page down or up keys. Each folder, when opened, has an *Action* option in its menu bar. Selecting the Action option allows the user to graph data, return to the another folder screen or, if in an Anatomic Pathology folder, return to the case list to select another case, if more than one case exists.

In this paper we have only touched on the major functions of version 2.0 of the CWS. Space does not permit discussion of the features planned for version 3 and 4 of this application.

The Clinical Data Repository

The CWS is the highly visible component of the information management strategy developing at UNC Hospitals. The CWS provides the appearance of clinical information integration by disguising the multiple systems and applications containing this data from the user and by itself it could be described as a "virtual" database system (3). For a variety of reasons, performance being the major reason, it is our opinion that a virtual database approach is not viable in the long-term. The second and most critical component of the information management strategy at UNC Hospitals is the development and implementation of the Clinical Data Repository (CDR) that will in time evolve into the computer-based medical record. The CDR has been built on the DB2 relational database technology. We believe that this database management system on IBM ES 9000 hardware can meet the performance needs of the Hospital and Medical Center. The overall information management strategy at UNC Hospitals is shown below in Figure 6.

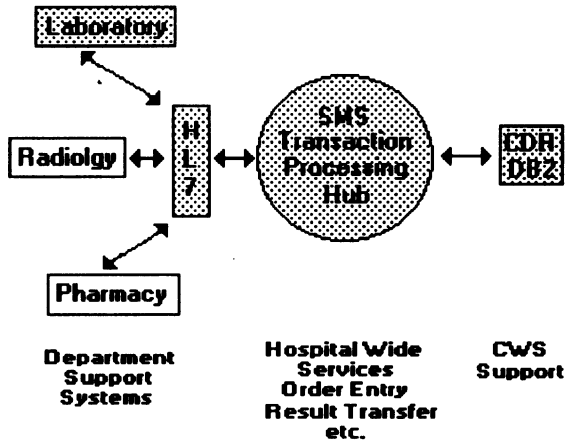

Figure 6. Shows a simplified information management architecture for UNC Hospitals.

The cornerstone of this approach is to take advantage of existing applications and only develop those applications that are not commercially available such as the CDR. We have elected to use the transaction processing system of SMS to move data between departmental systems and the CDR. In addition, the SMS application will provide standard HIS functions such as order entry, charge capture, etc. This approach is not dissimilar from that proposed for other institutions (4). The first phase in the implementation of this strategy, indicated by the shaded area in Figure 6 above, is the HL7 interface between the laboratory information system and the SMS clinical observation and results reporting system. The LIS-SMS interface is one of the first done by these two vendors in the complex environment of an academic medical center. Currently, the HL7 interface is live between these two systems, and after optimization of the queue processing, patient data moves between the two systems in real-time.

Work is currently underway on the COR-DB2 interface that will transfer, in real time, laboratory data to the CDR. With this interface in place, it will be possible for the CWS to obtain laboratory data from the CDR as opposed to emulating a terminal session on the LIS. The acquisition of clinical laboratory data from the CDR will markedly improve performance of the laboratory display function of the CWS. The CDR-COR-LIS interface will transfer eight million test results per year into the CDR.

At this time, the CDR contains discharge summaries, clinic notes and operative notes that are transferred to the CDR from the Softmed transcription system via an APPC application that was developed internally by ISD. Currently, patient data from radiology and anatomic pathology systems are moved daily by tape transfer into the CDR. We are awaiting delivery of the HL7 interface for these systems. Implementation of the HL7 interface to these systems will provide real-time data transfer to CDR. The Pharmacy system is to be addressed in the future.

Conclusion

The CWS makes it possible to access major parts of the medical record through a consistant user interface from multiple sites in the medical center improving access to clinical information. Planning is underway to finalize the design of version 3.0 of the CWS. The design goals include physician drug orders, alerts for drug interactions, an inpatient version and tools for monitoring use of the CWS. Since 1991, we have begun the implementation of a long-term information management strategy for UNC Hospitals that will provide the institution with flexibility by using HL7 compliant systems while allowing the institution to devote its resources to the development of systems that do not exist. The progress made in the last two years in the CWS and CDR projects has brought the Medical Center forward in meeting the information management goals outlined in the introduction of this paper.

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